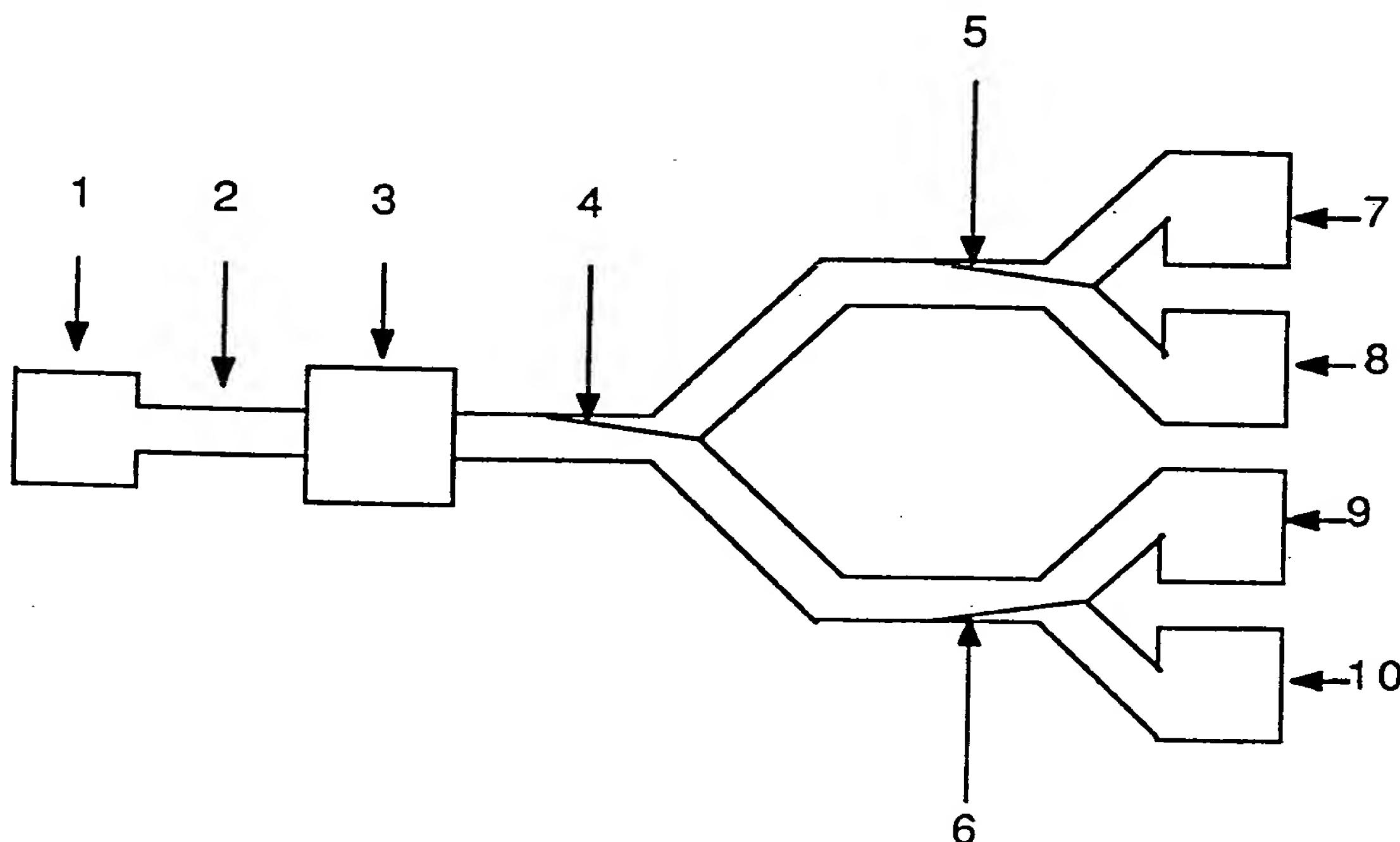


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(22) International Filing Date: <b>8 April 1991 (08.04.91)</b>		(81) Designated States: <b>AT (European patent), BE (European patent), CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB, GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.</b>	
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(54) Title: MICROFABRICATED DEVICE FOR BIOLOGICAL CELL SORTING



## (57) Abstract

Apparatus for sorting cells into spatially separate sub-groups, comprising a microfabricated moveable structure (4, 5, 6) for directing cells between distinct spatial locations.

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Microfabricated Device for Biological Cell Sorting

This invention relates to the sorting of biological cells into spatially separate sub groups. The criteria 5 for sorting may be applied to measurements obtained by any technique or techniques suitable for microfabricated or electronic implementation on a substrate.

Microfabrication and microelectronic techniques offer a 10 number of actual and potential measurement techniques that may be applied to characterize biological cells. Examples of these are microrheological measurements as disclosed in International Patent Application No. PCT/GB91/00289 and morphological measurements. When 15 suitably implemented such techniques can be applied on a cell by cell basis.

When characterizing a population of cells it can be of interest to workers to be able to isolate a sub 20 population whose measured parameters lie within certain bounds. This could enable, for example, the culturing of a cell line from sorted cells possessing a certain property or properties of interest.

25 We have discovered that recent developments in

microfabrication, namely the development of controlled, deflectable, microbeams capable of deflections in the order of a few micrometres, may be used to provide the component parts of microfabricated cell sorters.

5 Relevant microelectromechanical structures, and their formation by selective CVD techniques, are disclosed in: "Selective Chemical Vapor Deposition of Tungsten for Microelectromechanical Structures" by N. C. MACDONALD et al., Sensors and Actuators, 20 (1989) 123-133. The  
10 so-called "microtweezers" are activated by control voltages applied to electrodes.

According to the current invention such a machine is implemented by utilising a microfabricated moveable  
15 structure, preferably microfabricated beams, to direct cells between distinct spatial locations.

A particular implementation of the invention is shown in the drawing, which is a topological plan view of a  
20 substrate on which a cell sorter is formed. In this example the cells to be sorted, whose diameters may be only a few micrometres, are fed sequentially from an entry port 1, via a guiding structure 2, past a generalised sensing device or zone 3. Depending upon the  
25 result of the measurement and its interpretation the deflectable beams 4, 5, 6, are set into appropriate states to direct the cell into a particular destination,

for example, a hole 7, 8, 9 or 10 etched through the substrate. In the example shown the destination is structure 9. The beams, along with associated bifurcations can be extended to a tree structure of 'n' 5 levels thereby yielding  $2^n$  possible sorting sub ranges.

The absolute lengths of the channels are as short as possible while maintaining compatibility with interconnecting structures. The shafts 1, 3, 7-10 may be 10 fabricated by selective etching as disclosed in the copending International Patent Application referred to above; the etched substrate is closed by a glass/silica cover, thereby forming the channels as tunnels.

15 Typical dimensions of the entry port 1 are 500 $\mu\text{m}$  or less square; of the sensing zone about 100  $\mu\text{m}$  square; of the channels about 5 to 10 $\mu\text{m}$  in width and depth; of the holes (shafts) 7 - 10 about 500  $\mu\text{m}$  or less square; and of the beams, which are typically of constant 20 rectangular section, about 150 $\mu\text{m}$  long by 3 $\mu\text{m}$  square. The overall dimensions of the device could be 1cm square.

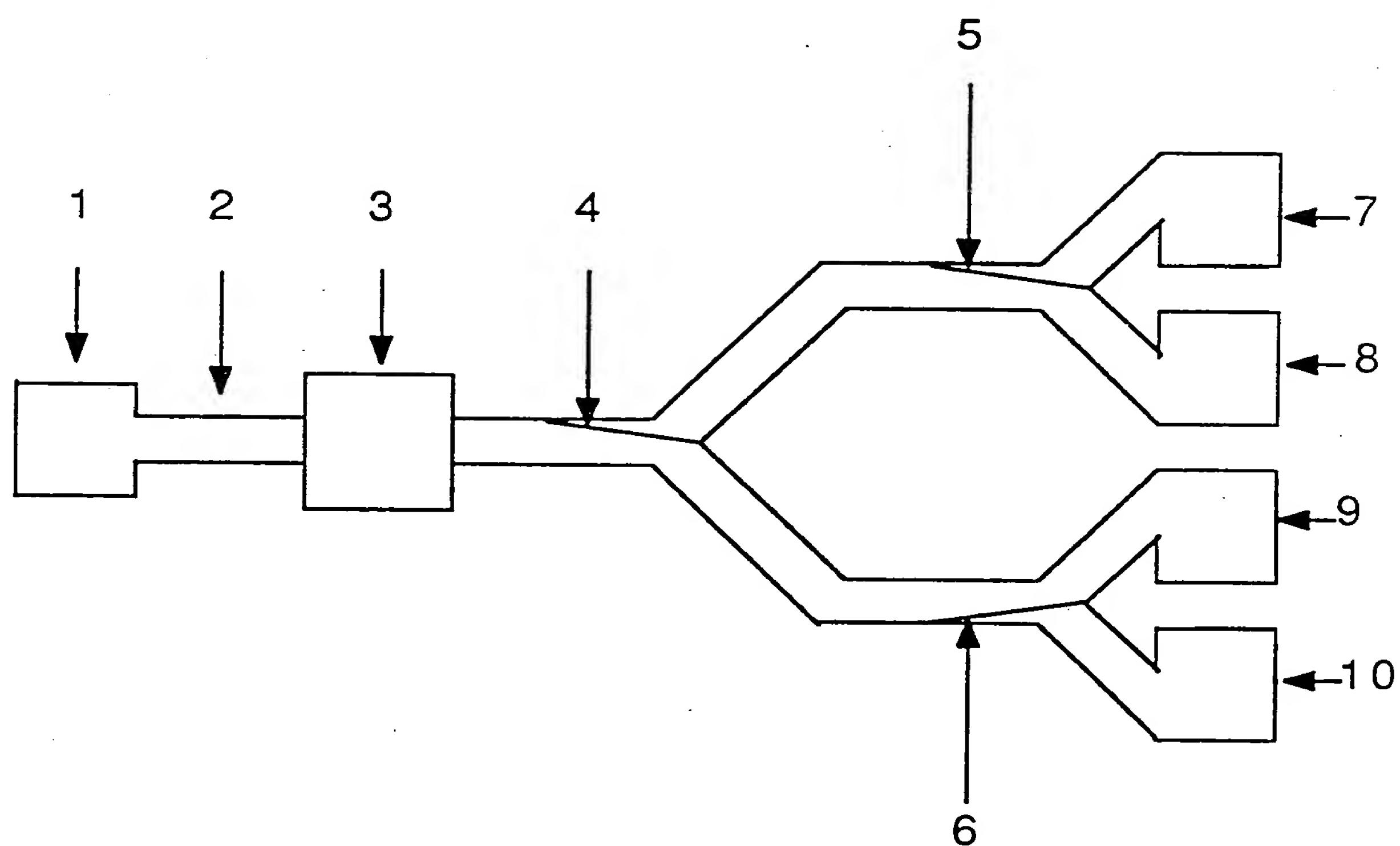
25 The beams are activated by selective control voltages applied as signals for control circuitry (not shown) operated, for example, under the control of a microprocessor or other computer. The computer is

programmed to control the beams' deflection in response to the desired cell-sorting procedural steps.

## Claims:

1. Apparatus for sorting cells into spatially separate sub-groups, comprising a microfabricated moveable structure (4, 5, 6) for directing cells between distinct spatial locations.  
5
2. Method for sorting cells into spatially separate sub-groups, comprising directing the cells into distinct spatial locations using a microfabricated moveable structure.  
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## INTERNATIONAL SEARCH REPORT

International Application

PCT/GB 91/00542

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)																
According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl. 5 G01N15/14 : G01N15/02 : B07C5/34																
II. FIELDS SEARCHED																
<table border="1"> <thead> <tr> <th colspan="2">Minimum Documentation Searched</th> </tr> <tr> <th>Classification System</th> <th>Classification Symbols</th> </tr> </thead> <tbody> <tr> <td>Int.Cl. 5 G01K : B07C : B01L</td> <td></td> </tr> </tbody> </table>		Minimum Documentation Searched		Classification System	Classification Symbols	Int.Cl. 5 G01K : B07C : B01L										
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III. DOCUMENTS CONSIDERED TO BE RELEVANT																
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		-/-														
<p><sup>10</sup> Special categories of cited documents :</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p>																
IV. CERTIFICATION																
Date of the Actual Completion of the International Search 12 JULY 1991	Date of Mailing of this International Search Report 30.07.91															
International Searching Authority EUROPEAN PATENT OFFICE	Signature of Authorized Officer HOOSON C.M.T. 															

III. DOCUMENTS CONSIDERED TO BE RELEVANT		(CONTINUED FROM THE SECOND SHEET)
Category	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
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ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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US-A-4676274	30-06-87	EP-A-	0293519	07-12-88
EP-A-177718	16-04-86	CA-A-	1256825	04-07-89
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